STUDIES OF THE TRANSPLANTATION OF KINDNEY I. Report Research of the Auto-transplantation.

AUTHOR(S):

Shimamoto, Tadaaki; Sasaki, Keiji; Ito, Takuji; Tanaka, Kaoru; Kitagawa, Michiko

STUDIES OF THE TRANSPLANTATION OF KIDNEY

I. Report Research of the Auto-transplantation.

From the 2nd Surgical Division, Mie Prefectural University Medical School, Yokkaichi, Japan.
(Director : Prof. Dr, T. FUJINO)

by

Assist. Prof. TADAAKI SHIMAMOTO, KEIJI SASAKI, TAKUJI ITO,
KAORU TANAKA • MICHIKO KITAGAWA.

The studies of kidney transplantation have been described by many surgeons since the records by ULLMAN and DESTELLO (1902), CARREL and GUTHRIE (1905) etc., but all their reports had been experimental reports untill recent time, because it was impossible to check efficiently the suppuration and thrombus-formation, which are most important for the transplantation of whole organs.

Recently the vascular surgery has advanced remarkably as a result of the improvement of antibiotic substances and anticoagulants. Consequently the study of the transplantation of whole organs has been stimulated, although there still remains even at present in case of homotransplantation the various mysterious phenomenons which must be a result of biological reaction and cause interrupting the success of transplantation, in spite of these difficulties, the homogenous transplantation of kidney in the human was performed recently by LAWLER et al. (1951), SERVELL (1951) and KUSS et al. (1951) etc..

These experimental studies have been performed by various methods of transplantation, that is, transplantation in to carotic, femoral, illiacal, splenic or another abdominal great vessels etc..

The transplantation into femoral vessel or carotic vessel is so easy in the point of technique that some investigators admired these methods. On the other hand, Floresco, Carrel and Guthrie, and the other authors et al. stressed the importance of placing the organs within the abdominal cavity and recommend the transplantation within the abdominal cavity, because the kidney transplanted by this method is not pressed by the surrounding-organs and can maintain the normal blood pressure and temperature of the kidney.

According to this method, further more, it is possible to utilize the abdominl great vessels for anastomosing the vessels and to avoid the formation of thrombus which is apt to occur in the case of suturing of small vessels.

Therefore, we began to make the studies of auto-transplantation utilizing the method of kidney transplantation within the abdomianl cavity.

METHOD AND MATERIAL

This study of transplantation was performed on the mongrel dog. Heparin and

(This research was supported by the subsidy for scientific Research from the Japanese Educational Department.)

other anticoaglants, were not utilized, except local using of sodium citratum during of suturing of vessels.

Fig. 1. shows our reformed or originated operative apparatuses for kidney transplantation within the abdominal cavity. These are as follows: (a) of Fig. 1. is a needle-holder with long handles, reforming Boynton's one; (b) is a double hemostatic clamp with long handles and str ng blades reforming Kimoto's one ; (c) is an apparatus which holds to fix the transplant and keeps away the bowels from slipping into the space around the suturing place of the vessels ; (d) is a hemostatic clamp with long handles and small blades for dog's vessels ; (e) are two series of curved s issors with the more longer handles, reforming Satinsky's scissor ; (f) is a holding bar of hemostatic-clamps reforming Carbon's bar ; (g) is a holder of the edge of the openirg of the vessel-wall during the suturing, and (h) are curved hemostatic clamps with long handles, and strong and narrow blades of various sizes reforming Satinsky's hemostatic clamp.

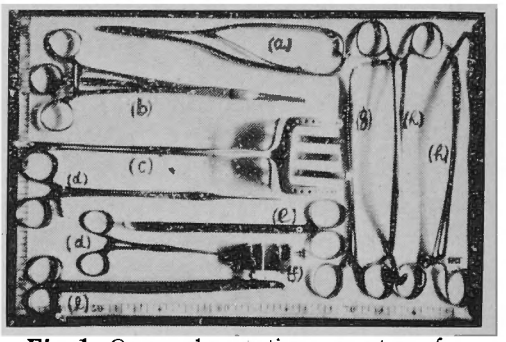

Fig. 1 Our used operative apparatuses for kidney transplantation within the abdominal cavity.

Braid blads silk on a atraumatic needle, which is made by Tatebeseishudo Co., was used through out in suturing of vessels. The function of the kidney was determined by observing the urinary excretion from the urinary fisula of the ureter at the abdominal wall, which is made by means of inserting a polyethylen tube into the ureter during the first few weeks after the operation.

METHOD OF OERATION

Fig. 2. shows the four methods of autotransplantation which have been performed in our experiments.

In the first type, the renal artery is cut-off together with a fusiform flap of the wall of the aorta surrounding its mouth. The renal vein itself is cut-off near it's root. The kidney is removed and irrigated by physiological saline salt solution, and these vessels are anastomosed again to their original dissected place.

In the second type, the renal vein and artery are dissected at the point near its root and removed. The openings thus produced are closed simply by suturing. The transplanted vessels are sutured to the edges of other suitable openings which are made in each abdominal great vessel, and both renal vessels are thus anastomosed to the abdominal great vessels.

In the third type, the renal artery and vein are dissected together with the fusiform flaps of the wall of the Aorta and Vena cava surrounding their mouth. The edges

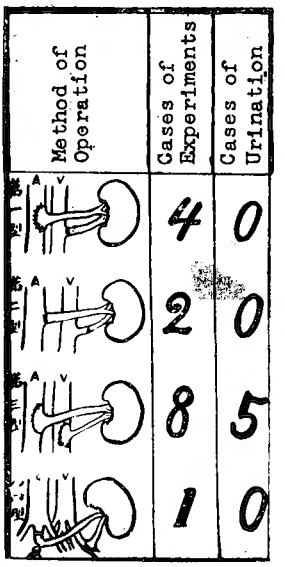

Fig 2 The method of operation and it's result.

of these patches of great vessel wall are sutured to the edges of the suitable openings which are made in each abdominal great vessels. This was performed by Carrel et al. in the case of homotransplantation and nominated as the "Patching Method."

In the fourth type, the inner iliacal artery and vein of the dog branch not from the common iliacal vessels as in the human body, but the Aorta and the Vene cava branch off the both sides of the external iliacal vessels and immediately afterward branch off the both sides of the inner iliacal vessels and as a result there only remains Vasa. sacral. media.

Therefore, the renal artery dissected at the point near its root is made end-to-end anastomosis to the small Aorta before the division off both sides of the inner iliacal artery, and the renal vein is made side-to-end anastomosis to the external iliacal vein. Of course, the openings produced by the dissection of the renal artery are closed by a simple suturing.

In all these experiments a polyethylentube is inserted into the ureter, way up into the pelvis of the kidney. The catheter is, then, tied in place with a catgut ligature around the distal end of the ureter. This ligature retains the catheter and controls bleeding from the ureter. A silk suture is used to fix the ureter to the edge of the stab wound of the abdominal wall near the dorsum of the anim l. The catheter is left in place for a few weeks.

RESULT AND DISCUSSION

The cause of anuria ; Table 1. shows the causes of anuria in these experiments. The "Excellent" in this table means the continuing of urination of the transplant during the life time of the animal after the operation. The results of each ope-

Table I. Results of Experiments

Method of Operation	No. of Experiment	Result	Cause of anuria and other complications in early stage
1st type	No. 10	poor	Thrombus in vein
〃	No. 11	〃	Stenosis and thrombus on suturing line of vein
〃	No. 22	〃	Thrombus in vein
〃	No. 23	〃	Thrombus in vein
2nd type	No. 12	poor	Stenosis and thrombosis on suturing line of vein
〃	No. 16	〃	Stenosis and thrombosis on suturing line of vein
3rd type	No. 2	poor	Slight stenosis and thrombus on suturing line of aortic wall, and post-operative bleeding
〃	No. 24	〃	Thrombus on suturing line of vein
〃	No. 25	fair	Thrombus and bleeding on the 7th day after the operation
〃	No. 31	poor	Embolism in first bifurcation of renal artery as a result of flowing of blood clot formed during the suturing
〃	No. 33	excellent	
〃	No. 34	〃	Local peritonitis due to remaining absorbent cotten in abdominal cavity, and adhesive intestinal obstruction
〃	No. 35	〃	
〃	No. 37	fair	Post-operative bleeding on 11th day after operation
4th type	No. 32	poor	Stenosis and thrombus on suturing line of vessels.

ration method are shown in Fig. 2.

All the methods, in which the renal vein itself is dissected, are apt to produce thrombus on the suturing line as shown in the Ist and 4th type of Table 1, for the vessels are too thin and small.

The method employed in 4th type is particularly difficult to make a suitable opening in the small external iliacal vein and to suture the patch with the renal vessel without stenosis, because these vessels are very small. According to the method of 3rd type, the thrombus on the line of suture is not produced so frequently and this method seems to be most excellent, because the larger vessels are used for anastomosis.

Table 1. shows the results of our experiment. The two cases which are described as "Fair in that table are No. 25. andNo. 37. of Experiment." They died on the 7th and 11th day after operation because of post operative bleeding. The other three cases continued their urination for a long duration after transplantation. In the 34th experiment the urination from the urinary fistula after the transplantation ceased temporarily because of the sharp bending of the polyethylentube inserted into the ureter, but no sooner was the inserting method of that tube improved, than the urination began again.

This case passed away on the 20th day after transplantation because of absorbent cotten remaining within its abdominal cavity, local suppurative peritonitis and adhesive intestinal obstruction. And also this case combined the slight hydronephrosis of transplant.

In the 33rd experiment, the polyethylen tube inserted into the ureter was immediately obstructed by blood coagulum on the first day after the transplantation, but exchanging it with a new tube, the urination began again.

In this case urination continued for 6 months until the animal was sacrificed.

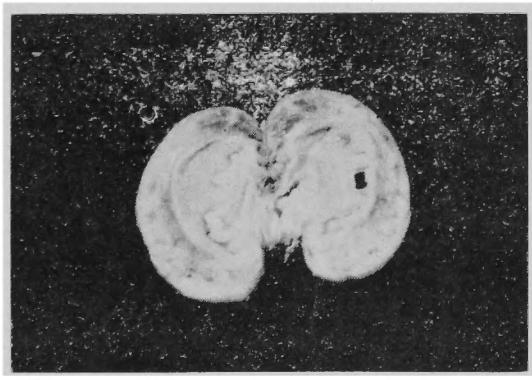

Fig.3 Hydronephrosis of the 33rd experiment. Overdistension of pelvis and a thining of cortex are noted.

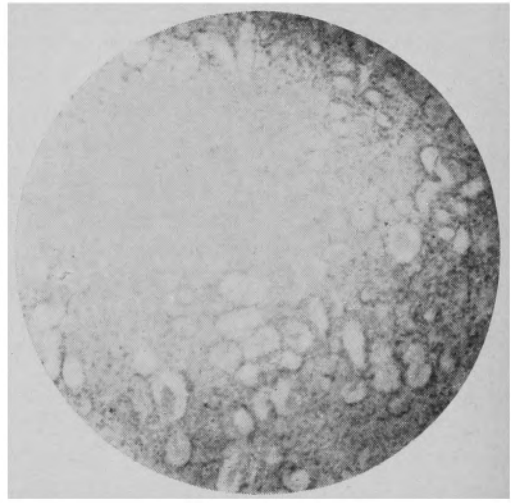

Fig.4 Microscopic figure of the cortex of the 33rd experiment. The thin wall of a hydronephrotic sac is composed of some remaining enlarged tubules and atrophic tubules with cast.

The kidney of this specimen showed distinct hydronephrosis. The Fig. 3. and 4. show the hydronephrosis of this specimen, in which a over distention of the pelvis and a thinning of cortex were noted. The tubules shrank in size but a few glomeruli remained normal. The thin wall of an hydronephrotic sac was composed of a small segment of atrophic tubules and remained enlarged tubules with cast, some hyaline glomeruli and normal glomeruli. The Fig. 5. shows the

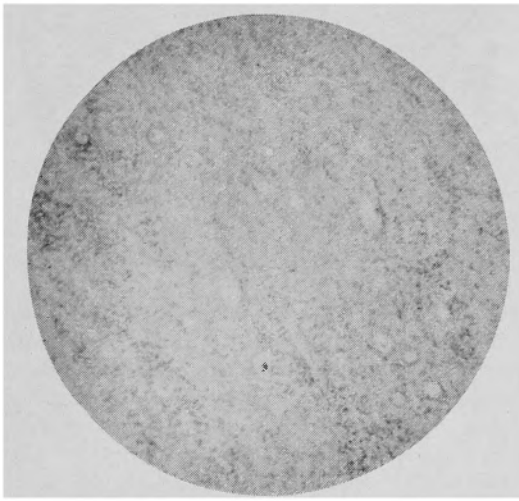

Fig.5 Microscopic figure of marrow of the 33rd experiment. An inflammation which large mononuclear leucocytes and lymphocytes predominate spreads chiefly through the interstitial tissues marrow.

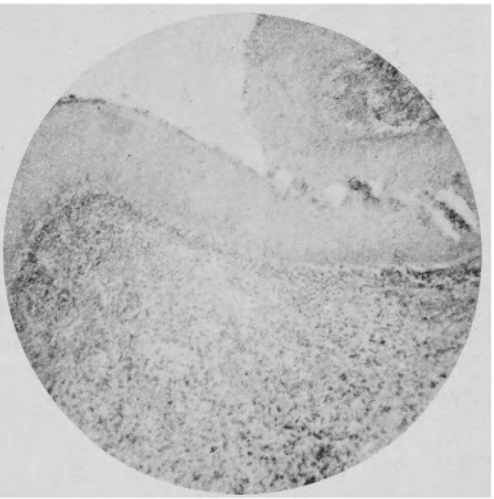

Fig.6 The ureter of the 33rd experiments is enlarged and thickened as a result of the stricture at the portion of abdominal wall of urinary fistula.

microscopic figure of its marrow. An inflammation which large. mononuclear leucocytes and lymphocytes predominate spread chiefly through the interstitial tissues of the marrow. The Fig. 6 shows the microscopi figure of its ureter. The ureter was enlarged and thicked due to the stricture at the portion of the abdominal wall of the urinary fistula. The epithelium of mucous membrane and submucous connective tissue of the ureter increased remarkably, and there was an infiltration of cells in which lymphocytes and large mononuclearcytes predominated.

According to these findings, we can assume that an abdominal urinary fistula itself and the stricture of its opening must be the cause of a chronic ureteritis, pyelitis, interstitial nephritis and hydronephrosis.

In the 35th experiment, the tube inserted into the urinary fistula was pulled out by the dog itself on the 7th day after the operation and the urination ceased temporarily for a few days, but began to excrete again when a new tube was replaced. The duration of urination was for 3 months. Then it gradually ceased and the urinary fistula was completely closed.

This dog was sacrificed 6 months after the transplantation when it was used for another experiment on the auricle of the heart which caused blood stagnation. In this case the transplanted kidney showed a remarkable contracted kidney as in Fig. 7 as compared with the untransplanted kidney of the other side. A hydro-

nephrosis was found distinctly in the sectionary surface of its specimen. Fig. 8 shows that microscopic figure.

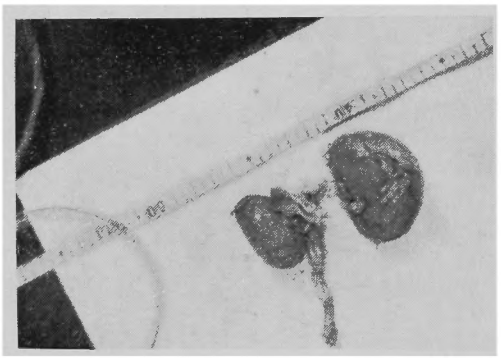

Fig.7 The transplanted kidney and untransplanted kidney of the 35th experiment. The transplanted kidney shows a remarkable contracted kidney compared with the untransplanted kidney of the other side.

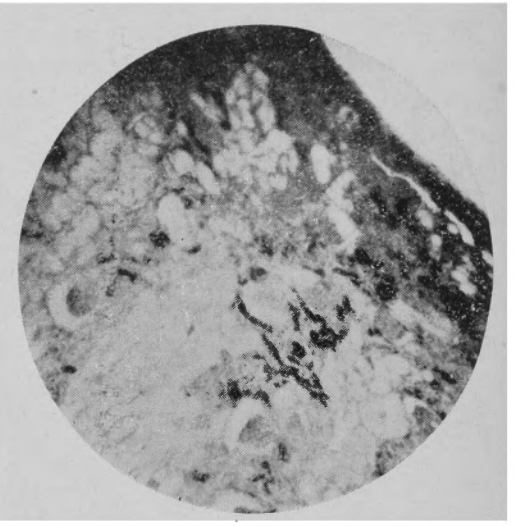

Fig.8 The microscopic figure of the 35 experiment. The thin wall of an hydronephrotic sac is composed of some remaining enlarged tubules and atrophic tubules with cast. The stagnation and bleeding are found, for this dog was sacrificed when it was used for another experiment on the auricle of the heart which caused blood-stagnation.

The histological finding of the kidney was almost identical to that of the 33rd experiment, but the infiltration of cells and thickening of the wall of the ureter were not so remarkable in this case as in the 33rd experiment. Necrosis was not found anywhere and a few normal glomeruli and tubules still remained.

DISCUSSION AND SUMMARY

The most important causes of failure are the thrombosis and stenosis on the suturing line. Particulary in the method of suturing small vessels the thrombosis occurs in almost all of them, but this result is unavoidable in the small vessels due to its lower blood pressure and slow stream. Therefore if we are going to avoid these greatest causes of failure, it is assumed that the kidney transplantation should be performed so as to utilize the great vessels for anastomosis. From such a view point, it is natural, in our opinion, that the 3rd type-method had gained the best result. As to the other causes of failure of this transplantation, there are secondary haemorrhaging, stenosis on the suturing line of the vessels, peritonitis, and bowel obstruction etc., but all these causes can be avoided by means of our various skillful procedures and the application of antibiotic in our opinion. As to the tardy complication which was observed a long time after the operation, there were hydronephrosis, ureteritis, pyelitis, ascending interstitial nephritis etc..

As has been previously mentioned, it is assumed as a result of pathological studies, that the hypronephrosis must occur due to the scarred stenosis at a portion of the abdominal wall of the urinary fistula and also uretritis, pyelitis and interstitial nephritis may occur according to the infection through an urinary fistula.

Therefore these tardy complications must be prevented by means of a suitable procedure of the urinary fistula, in our opinion. And if this is done, the succesful autotranplantation of the kidney will be possible.

But there is still now one doubtful problem, that is, as has been previously mentioned, the contracted kidney as a tardy complication, which is usually combined with the hydronephrosis, uretritis, and chronic interstitial nephritis.

The followi g facts may be considered as to the cause of it :

(1) A degeneration and an atrophy takes place in the transplanted kidney due to the stopping of blood circulation to transplant during the suturing of the vessels.

(2) The blood circulation of the transplanted kidney has been decreased, as Carrel had described it, owing to the scaring stenosis of adjacent tissue of a suturing line of vessel. Such scaring was serious in our cases too.

Conclusion

1) Some new apparatuses for transplantation of kidney are described.
2) The method applying the Carrel's patching method for autotransplantation is the best among the four metods of our experiments.
3) In the case of autotransplantation, the greatest cause of failure is a thrombosis on the suturing line of the vessels. And besides, the other remaining causes are secondary haemorrhage from the suturing line, stenosis of the suturing line, peritonitis and contracted kidney etc.. As to the tardy complication, peritonitis, ureteritis, interstitial nephritis and hydronephrosis etc. are observed.
4) It is assumed t'at in our autotransplantation of kidney that all the causes of failure in the early stages and almost all the tardy complications, except the contracted kidney after the transplantation, the cause of which is not clear at present, can be surely prevented by means of the adequate surgical procedure and precaution.

(The main point of this record was reported on 7. Oct. 1952. at Kinki Surgical Society.)

References

1) Carrel, A. and Guthrie, C. C.: Anastomosis of Blood Vessels by the Patching Method and Transplantation of the Kidney. J. A. M. A. **47,** 1648-1651, 1906. 2) Carrel, A.: Doppel Nephrektomie und Reimplantation einer Niere. Arch. f. Klin. Chir. **88,** 379-411, 1909. 3) Dederer, C.: Studies in the Transplantation of Whole Organs. I. Auto-transplantation of the left Kidney to the Neck with Right Nephrectomy in the Dog. J. A. M. A. **70,** 6-9 1918. 4) Ibuka, K: Function of the Homogenous Kidney Transplantation. A. J. M. Science. **171,** 420-433, 1926, 5) "Kidney transplantation" in Foreign letter in J.A.M.A. **146,** 393, 1951. 6) Kuss, R. and Tienturie, T.: From Lawler's Report. 7) Lawler, R. H. et al.: Homotransplantation of the Kidney in the Human, A preliminary Report. J.A.M. A. **114,** 844-845, 1950. 8) Lawler, R. H. et al.: Homotransplantation of Kidney in the Human, Suppremental Report of a case. J. A. M. A. **147,** 45-46, 1951. 9) Negishi, H.: Jinkino no Jikkenteki Kenkyu, Nippon Hinyokikagaku Zasshi. (Japanese.) **43,** 183-192, 1952. 10) Tachibana, E.: Ishokujin no Jikkenteki Kenkyu, Ist Report. Okayama Igakukai Zasshi. (Japanese. **54,** 896-918, 1942. 11) Tachibana, E.: Ishokujin no Jikkenteki Kenkyu, 2nd Report. Okayama Igakukai Zasshi, (Japanese.) **54,** 1071-1086, 1942. 12) Williamson, C. S. : Some Observation on the Length of Survival and Function of Homogenous Kidney Transplants. J. Urology. **10,** 275-287, 1923. 13) Williamson, C. S.: Further Studies of the Transplantation of the Kidney. J. Urology. **16,** 231-253, 1926.

腎臓移植の実験的研究

第1報 自家移植

三重県立大学医学部外科学第2講座（藤野敏行教授 指導）
助教授 島本忠明・佐々木敬二・伊藤卓爾・田中 馨・北川美智子

吾々の改良及び創始した腎移植用の器械を用い，犬に於て自家腎移植の研究を試みた．，4通の移植法を行つた所，大動脈，大静脈の瓣状片を附着した腎動静脈を大動静脈に吻合移植する方法が最良の結果を得た．

失敗の最大原因は血管縫合線に於ける血栓形成である．その他縫合線からの二次的出血，吻合部の狭窄，腹膜炎，輸尿管炎，間質性腎炎，腎水腫，他にもある．

尚一例腎萎縮と腎水腫の合併したものがありその腎萎縮の原因は不明である．

吾々の腎自家移植では早期の失敗の全原因は現在その原因が不明な萎縮腎を除いた凡ての晩期合併症と共に適当な外科的処置により防ぎ得るもので，その永久移植は可能と考えられる．

（本研究は文部省科学研究費の援助を受けた）

気管枝性肺臓癌に対する左肺剔除術に於ける心嚢内血管切除

Kirklin J. W. & Robert W. Jawpolis
The Journal of Thoracic Surgery (1953. 3月)

肺臓癌に於て癌組織の広汎切除の目的で血管を心嚢内で切除する適応として (1)その拡り方が心嚢外では肺動静脈を安全に処理出来ない様な場合 (2)肺動脈，下肺静脈或は左主気管枝及心臓後面のリンパ腺及軟部組織に転移のある場合である．

左肺切除に際して心嚢内切除術式概略について述べると左心耳にまたがり横隔膜神経の前或は後で心嚢に切開を加へ肺動脈及大動脈部を広く露出出来る様心嚢を方形葉状に開き上下肺静脈を結紮切断，左肺動脈を動脈靱帯の末梢で二重或は三重結紮後切断した後切除心嚢片，リンパ腺及軟部組織をまとめて肺の方へ廓清除去する．迷走神経は普通反回神経分岐部末梢で切除，更に傍気管枝リンパ腺分岐後部リンパ腺を廓清し気管枝をSweetの方法で切除し肋膜片及び（之を蔽ふ）心嚢部の組織欠除はそのまゝにする著者等の18例手術例中1例以外併発症はない．

（辻 秀哉抄訳）